

Sighted Children's Knowledge of Environmental Concepts and Ability to Orient in an Unfamiliar Residential Environment

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Abstract: In an unfamiliar residential neighborhood, 24 10- and 6 year olds were individually evaluated and compared on their conceptual knowledge of a residential neighborhood. The findings indicate there are statistical and practical differences between the two age groups. Implications for teaching orientation and mobility to children with low vision are discussed.

Most schoolaged children are able to walk to school, to a friend's house, or playground in familiar neighborhoods. There may be protections along the way, such as crossing guards, but few children get lost walking in their familiar neighborhoods. Daily walking to and from school, friends' houses, and local stores helps children develop the concepts and skills they need to remain oriented in their neighborhoods. Varied travel experiences are thought to be important to the development of the ability to travel independently (Cornell, Heth, & Broda, 1989; Siegel & White, 1975, Spencer & Darvizeh, 1981).

Wayfinding theorists have studied children's and adults' ability to learn routes through environments and have studied methods of facilitating this learning process in sighted children (Acredolo, Pick, & Olsen, 1975; Cornell & Hay, 1984; Cornell et al., 1989; Cornell, Heth, & Rowat, 1992, Cousins, Siegel, & Maxwell, 1983; Darvizeh, & Spencer, 1984; Herman,

Kolker, & Shaw, 1982; Siegel & White, 1975; Spencer & Darvizeh, 1981). Studies of children's wayfinding indicate that having children as young as age 3 walk routes provides the best indication of their ability to learn routes through the environment, and that having children indicate the correct path on videos and slides, order pictures of the path, draw maps of a route or orally describe a route are not as reliable (Cornell & Hay, 1984; Cornell et al., 1989; Cornell et al., 1992; Cousins et al., 1983; Darvizeh & Spencer, 1984; Spencer & Darvizeh, 1981).

Darvizeh and Spencer (1984) found that the 20 3- and 4-year-old children in their study were capable of retracing a route walked only once when landmarks were pointed out to them during the original walk. Children (aged 3-4) from the same nursery school (Spencer & Darvizeh, 1981) individually led the experimenter to a destination (a museum) that they had walked to as a group only three times before the test. Furthermore, all but one child were able to

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lead the experimenter to their homes from their nursery school.

Cornell et al. (1992) indicated that 12 year olds' ability to learn routes in an unfamiliar environment that they had walked only once previously was no different from that of adults. When led to a destination once, the adults and 12 year olds demonstrated equal difficulty retracing the exact route, but generally traveled in the correct direction and returned to the destination. Both groups were more successful at following an exact route when landmarks were pointed out to them.

Long and Hill (1997) stated that wayfinding refers more broadly to the process of navigating through an environment, and that the terms *orientation* and *mobility* (O&M) better describe the cognitive processes used by persons with visual impairments. *Orientation* is defined as "the process of using the senses to establish one's position and relationship to all other significant objects in one's environment" (Hill & Ponder, 1976, p. 3), and *mobility* is defined as "the capacity or facility of movement" (Lowenfeld, 1976, quoted in Hill & Ponder, 1976, p. 1). O&M is also concerned with how children and adults learn routes through their environment, but places greater emphasis on the concepts needed to maintain and regain orientation while walking with impaired vision.

The literatures on wayfinding and O&M provide insights into working with children with low vision. Since a person with low vision may use vision as the primary sense for orientation, knowledge of the typical developmental patterns in sighted children's wayfinding may be germane to understanding where children with low vision deviate from their sighted peers in

the ability to learn new routes through the environment. Children with low vision who exhibit a deficit in this ability to remain oriented while walking to known destinations benefit from instruction in O&M (Ambrose & Corn, 1997).

There is a dearth of literature on children's conceptual knowledge of the environment (Blades & Spencer, 1988; Guth & Rieser, 1997). "Conceptual knowledge (sometimes referred to as semantic knowledge) refers to knowledge of general patterns" of an environment (Guth & Rieser, p. 15). When Ambrose and Corn (1997) studied the effects of O&M instruction on the conceptual knowledge of nine children with low vision (one 4 year old, one 5 year old, one 9 year old, three 10 year olds, two 11 year olds, and one 16 year old), they found that all the children had limited knowledge of concepts associated with oriented travel, such as locating and using street signs, intersections, and traffic patterns. Only the 16 year old was an oriented traveler prior to instruction; the other eight children did not demonstrate an understanding of landmarks and lacked the concepts necessary to establish and update their location in environments as they walked. The simple act of walking around a block disoriented the children, many of whom were unable to state that they had returned to the original corner. After O&M instruction, the children had a greater ability to remain oriented using conceptual knowledge of the environment.

Landmarks

Long and Hill (1997) described two types of landmarks—primary and secondary—that persons who are visually impaired need to maintain or regain orienta-

tion. A primary landmark (such as an escalator) is always present, whereas a secondary landmark (like the intermittent sound of the motor of a water fountain) is not always present or not always encountered when traveling. Long and Hill indicated that both types of landmarks are used to provide the traveler with precise information about a unique location.

Wayfinding theorists (Acredolo et al., 1975; Cornell et al., 1989; Darvizeh & Spencer, 1984) have studied the similarities and differences between sighted adults and children's use of landmarks. They have found that young children, older children, and adults use landmarks and are able to learn new routes when landmarks are specifically pointed out at choice points by the tester.

Darvizeh and Spencer (1984) examined preschool children's learning of novel routes and the extent to which an adult can facilitate the process by mentioning, on the "learning trip," the presence of a number of usable landmarks. Fifteen of the 20 children were able to retrace the two novel routes when an adult pointed out landmarks, but only six could do so when no landmarks were mentioned. Darvizeh and Spencer recorded the landmarks the children used to describe the routes after walking them and categorized the landmarks as public (permanent objects suggested by an adult) and private (ephemeral objects or actions no longer present). They concluded that both public or private landmarks occupied a key position in the children's accounts of newly learned routes.

More research is needed on the development of children's conceptual knowledge of an environment (for example, the age at which a child can locate a house using only

a street address) and on what landmarks sighted children use to establish and maintain their orientation. The purpose of the study reported here was to compare and categorize the concepts of an unfamiliar residential environment of two age groups of typically developing children.

Method

SUBJECTS

The subjects were 24 children, half of whom were age 6 (mean = 6 years, 8 months; $SD = 0.18$) and half of whom were age 10 (mean = 10 years, 6 months; $SD = 0.28$), who were recruited using word of mouth and printed flyers. The subjects were included in the study if they met the age requirement, had no identified disabilities (as indicated by their parents), and showed a recent report card indicating a grade of A or B in reading.

Of the 24 subjects, 11 were boys (four 6 year olds and seven 10 year olds) and 13 were girls (eight 6 year olds and five 10 year olds). An effort was made to include subjects who resided in areas that did not resemble the test site.

Instrument

The author developed the Assessment of Children's Wayfinding (ACW), which includes six subscales with six items in each, rated on a Likert-type scale. The subscales assess the subjects' knowledge of signs, addresses, traffic, environmental objects, landmarks, and orientation. After 14 professionals in the field of visual impairments and four parents critiqued the ACW for content validity, questions were rewritten, discarded, or kept. The ACW was pilot tested on six subjects: two 9 year olds, three 6 year olds, and one 3 year old (none

of whom took part in the study). After the ACW was piloted with three subjects, the original instrument was shortened from 50 questions to 36. The shorter ACW was then piloted on three additional subjects; two of the three pilot subjects were videotaped, so the videotapes could be used in training reliability checkers.

The subjects' responses to each item on the ACW were scored using a 5-point Likert-type response scale: 0 (no response), 1 (says doesn't know), 2 (immediate incorrect answer), 3 (asks for information; incorrect response follows), 4 (asks for information; correct response follows), and 5 (immediate correct answer).

Subscales

Signs. Signs on the roadside may perform one of three functions: to warn, to regulate, or to identify (Smith & O'Donnell, 1991; Williams, Hoff, Millaway, & Cassidy, 1982). The subscale, signs, tested the subjects' abilities on all three types of signs with the categories knowing location, understanding meaning, and using signs appropriately.

Addresses. Addresses are useful in locating a desired destination. To locate destinations, the traveler assumes that addresses run in sequential order and can occur in different patterns (Hill & Ponder, 1976; Jacobson, 1993; Long & Hill, 1997; Pogrud et al., 1993; Smith & O'Donnell, 1991; Welsh & Blasch, 1987; Williams et al., 1982). The six items in the subscale, addresses, tested the subjects' abilities in knowing location, understanding meaning, and locating destinations.

Environmental objects. Environmental objects are permanent objects in the environment that can be classified by their phys-

ical characteristics, their functional uses, and the actions they make or that can be made with them (Long & Hill, 1997). The environmental objects tested in the ACW were a telephone pole, corner, mailbox, sidewalk, curb, and wheelchair ramp. In the study, the subjects were asked to point to or touch each one.

Traffic. The subscale, traffic, included items that addressed traffic patterns and terms specific to traffic, such as *intersection* (Guth & Rieser, 1997).

Landmarks. The subscale, landmarks, included both self-directed and tester-directed landmarks (Cornell et al., 1989; Cornell et al., 1992; Darvizeh & Spencer, 1984). There were three reporting areas for landmarks and three items that were directions to locations using landmarks. To be scored correct, the self-directed landmarks had to be both unique and permanent objects. The tester (the author, a certified O&M specialist, who conducted all the assessments) and the reliability checker recorded all the landmarks mentioned by the subjects.

Orientation. Orientation for the purpose of wayfinding may be linked to spatial orientation (Long & Hill, 1997; Rieser, 1979), landmarks (Hill & Ponder, 1976; Jacobson, 1993; Siegel & White, 1975; Welsh & Blasch, 1987), cardinal directions (Hill & Ponder, 1976; Jacobson, 1993; Welsh & Blasch, 1987), following directions (Hill & Ponder, 1976; Jacobson, 1993), and Euclidean logic (Piaget, Inhelder, & Szeminska, 1960; Potter, 1995). The subscale, orientation, evaluated these aspects of orientation.

TEST ROUTE AND PROCEDURES

The route covered nine blocks (4,400 feet in length), and its start and finish points were the same location. The route, which doubled back on itself five times, was located in a residential neighborhood. The blocks had sidewalks, the houses had visible addresses, and it was an area that was not known to the subjects.

Each subject was tested individually. The tester and subject walked together along the test route and stopped at 13 locations, where the tester read questions from the protocol. After each item was read, the tester remained silent up to 10 seconds or until the subject responded. When the subject asked for information after an item was read, the tester replied with a standard response and responded to the subject's responses in a neutral manner. On items that required the subject to lead the way, the tester walked behind the subject but was never less than 5 feet from the subject; otherwise, the tester and subject walked side-by-side. All the subjects were paid \$25 for participating.

Each child's parents provided the child's date of birth and reading grade and the location and description of the neighborhood in which they resided. The parents were given a map of the route and were invited to follow 7 to 10 feet behind the tester. Five of the 24 subjects were followed by a parent. After a trial was completed, the tester answered all the questions the subject and his or her parents had about the study.

RELIABILITY CHECKER

The reliability checker, a certified O&M instructor, was paid \$10 an hour during training and testing. He was trained at the test site and was asked to demonstrate reli-

ability by scoring the videotaped protocol. The reliability checker shadowed and independently scored 37% of the trials (nine trials) of five of the 10 year olds and four of the 6 year olds. He remained silent during the trials, remained within earshot of the subjects, and independently scored the subjects' responses. The percentage agreement between the reliability checker and the tester on the videotaped protocol was 96%.

All scored protocols were returned to the tester for data analysis. The data were analyzed using SPSS for Windows version 6.1. The tests used for data analysis were Cronbach's alpha, a 2 X 2 multivariate analysis of variance (MANOVA), a within-subjects' analysis of variance (ANOVA), effect size, and Pearson's *r*.

Results

The study compared two age groups of typically developing children's concepts of an unfamiliar residential environment and catalogued the landmarks the children indicated. Two relationships were tested: between the subjects' age and sex and knowledge of environmental concepts and between the subjects' age and performance on the ACW. There were no incomplete trials. The performance between and among subject groups was analyzed, the ACW's subscales were tested for internal consistency, and tester reliability was measured.

TESTER RELIABILITY

Percentage agreement was computed between the reliability checker's and tester's scores. Agreement was defined as having the exact same number circled for each response. Percentage agreement was individually calculated for each of the nine subjects. Interobserver reliability was cal-

culated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. Percentage agreement between the checker and the tester ranged from 80.55% to 94.44%, with a mean of 89.14%.

ASSESSMENT OF CHILDREN'S WAYFINDING

Cronbach's alpha was used to determine the internal consistency of the ACW. Coefficient alpha is a measure derived in psychometrics for the reliability of a score. In alpha factoring, the interest is in discovering common factors among variables taken from a population of variables (Tabachnick & Fidell, 1989). An alpha of 0.70 is considered to be sufficient to establish whether a subscale is internally consistent.

The alpha values for the six subscales are shown in Table 1. Items that were found to lower the internal consistency of a subscale below 0.70 were deleted from further analyses. Since removal of these items left the subscales with unequal numbers of items, subsequent analyses were computed using standardized z-scores.

Three of the six subscales were found to be internally consistent. Two subscales (orientation and landmarks) were demonstrated to be internally consistent without item deletion. One subscale, environmental concepts (alpha = 0.46), increased to an alpha of 0.71 when the item "How many corners are at this intersection?" was

deleted. Three subscales (addresses, traffic, and signs) did not demonstrate internal consistency as separate subscales (see Table 1).

Relationship between subjects' age and sex and wayfinding concepts

All statements about statistical significance are based on a .05 Type I error rate. The principal measure considered for the statistical analyses was the mean rating on each of the six subscales. The higher the mean, the greater the number of items for which the subject received closer to a "correct" score. The general pattern of the findings was that age affected the subjects' performance on the six subscales. The mean scores for the 24 subjects, by age, are depicted in Figure 1, which indicates a main effect for age and an interaction by subscale.

A 2 X 2 MANOVA was performed on six dependent variables (environmental objects, addresses, traffic, signs, orientation, and landmarks); the independent variables were age (6 and 10) and sex. Using Wilks's criterion, the author found no interaction between sex and age, $F(1, 6) = 0.16$, and no significant main effect for sex, but a significant main effect for age, $F(1, 6) = 4.08$. Univariate F tests suggested that for all six subscales, age affected performance (see Table 2). The size of the between-subjects effect for age was .57.

Table 1
Cronbach alpha values for each subscale computed with standardized z-scores.

Subscale	Alpha	Item	Alpha if item is deleted
Traffic	.38	"Point to the traffic."	.57
Environmental objects	.46	"How many corners are at this intersection?"	.71
Signs	.56	"Which street is Fairfax?"	.62
Addresses	.58	"Why are there two addresses on this sign?"	.68
Orientation	.72	"Take three giant steps and turn right."	.77
Landmarks	.76		

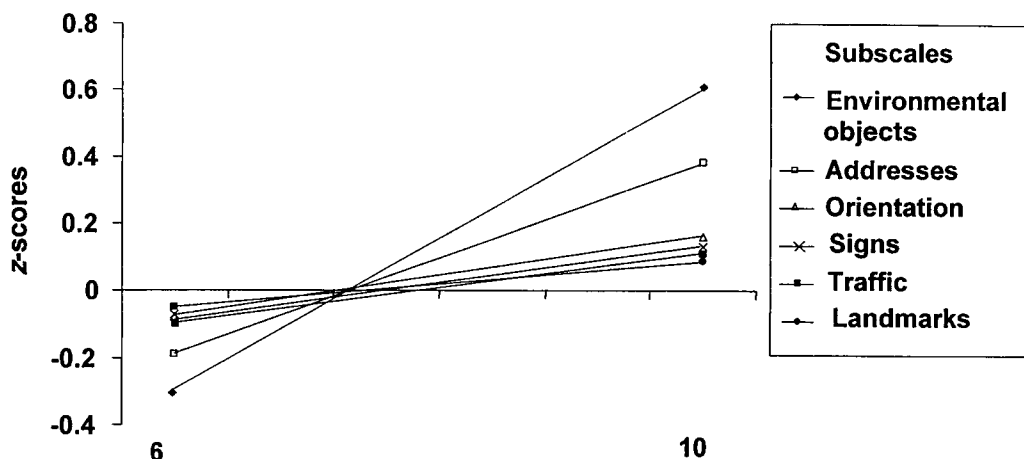


Figure 1. Mean subscale scores, by age.

Relationship between subjects' age and performance on each ACW subscale

Visual inspection of Figure 2 suggested there may be an identifiable order to the subscales that is constant across the two age groups. For both age groups, the subscale, environmental objects, produced the highest means compared to the other subscales. The subscale, addresses, produced the second highest subscale means. The subscales, orientation, traffic, signs, and landmarks are ranked from highest to lowest. A within-subjects ANOVA indicated that the interaction of age by subscale was not significant, $F(1, 5) = .53$. The effect size of age by subscale interaction was .13. Pearson r correlations indicated that the individual items in each subscale were not correlated with each other.

Table 3 lists the results of the correlations between the subscales. The finding that performance on the subscale, landmarks, was correlated with performance on the subscale, orientation ($r = 0.80$), indicates that the subjects who did well identifying and using landmarks were more likely to complete the six orientation tasks correctly. That the subscale, orientation, was correlated with the subscale, signs ($r = 0.77$), indicates that the ability to find, read, and use signs may have been associated with the subjects' ability to complete the orientation tasks correctly.

On average, the 10 year olds scored higher than the 6 year olds on the orientation subscale with regard to the landmarks identified, but both age groups often indicated the same landmarks. The subjects'

Table 2
Summary of MANOVA: Main effect for age.

Variable	Hypothesized SS	Error SS	Hypothesized MS	Error MS	F
Address	8.91	11.26	10.14	.57	15.83*
Environmental objects	3.80	11.89	6.80	.59	11.44*
Landmarks	6.27	15.81	6.27	.79	7.93*
Orientation	10.14	11.47	10.14	.57	17.68*
Signs	7.55	14.47	7.55	.72	10.44*
Traffic	8.91	12.27	8.91	.56	15.82*

* $p < .05$.

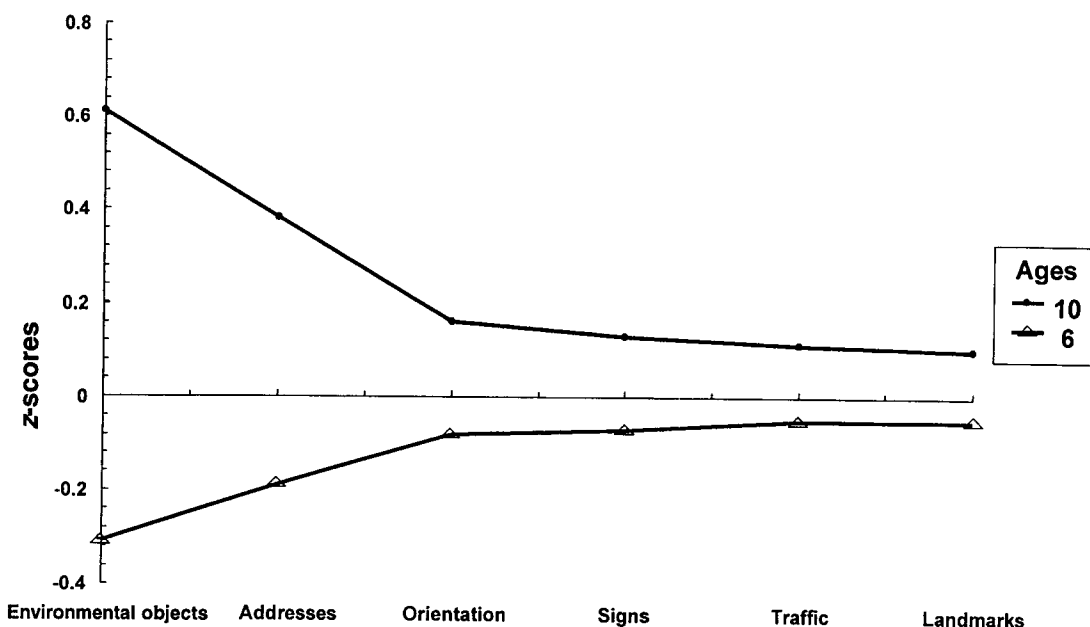


Figure 2. Subscale trends: Highest to lowest mean z-scores.

reported landmarks tended to be near objects. When the landmarks mentioned by the subjects were analyzed, four categories emerged: primary (Long & Hill, 1997), private, picture, and story (defined later). Both age groups indicated all four types of landmarks, although primary landmarks were mentioned more often than any other type and the subjects often named several types of landmarks at a single reporting station.

In summary, the 10 year olds performed significantly better on all six subscales than did the 6 year olds. Three of the ACW subscales were found to be internally consistent. Performance on all subscales did not vary significantly within each age group.

The subscale, landmarks, appeared to be correlated with the subscale, orientation.

Discussion

AGE AND PERFORMANCE

Conceptual knowledge of the environment

The 6 year olds demonstrated some basic concepts of residential environments, but, on average, did not demonstrate oriented travel in an unfamiliar residential environment. They focused primarily on near space and paid little attention to the route as they walked. For example, while walking the route, they collected sticks, pointed to dogs,

Table 3
Correlation coefficients between the six subscales.

	Addresses	Landmarks	Orientation	Signs	Traffic
Environmental objects	0.66	0.52	0.66	0.48	0.71
Addresses		0.62	0.62	0.66	0.74
Landmarks			0.80	0.68	0.62
Orientation				0.77	0.58
Signs					0.64

and generally showed no concern for maintaining orientation.

The 10 year olds demonstrated oriented travel and conceptual knowledge of a residential neighborhood and seemed to apply these concepts as they remained oriented to the unfamiliar residential neighborhood. They used their knowledge of objects in the environment at a variety of distances from them and were able to return to locations, although out of sight, given one-step and two-step directions. Two subjects were able to locate a unique destination given four-step directions. The 10 year olds displayed confidence while walking, knowledge of the environment, and an awareness of their location in the environment. For both age groups, there was no significant difference between the performance of boys and girls.

Performance on each ACW subscale

The 6 year olds scored consistently low and the 10 year olds scored consistently high across the subscales. This finding may indicate that knowledge of environmental objects, addresses, orientation, signs, traffic, and landmarks develops in unison. The two age groups' performance on individual items in each of the six subscales was as follows.

Environmental objects. Both groups scored the highest on this subscale. The most surprising finding was that all the subjects did not score perfectly. All the subjects were able to touch a sidewalk, but many 6 year olds and several 10 year olds were unable to locate a curb when requested to do so. In fact, more 6- and 10 year olds knew a wheelchair ramp than a curb.

Addresses. The 10 year olds had little difficulty with the items on this scale and could be considered capable of using an

address to find a destination in a residential neighborhood. The 6 year olds knew where to look for an address, but did not demonstrate the ability to locate a building after being given its address. They did not understand the concept of the odd and even sides of the street, but, on average, demonstrated knowledge of the purpose of addresses.

Orientation. The 6 year olds had the most difficulty with the item "Walk all the way around the block until you get to here again" and, in general, did not demonstrate the ability to return to points along the route whether or not they had previously selected landmarks at those locations. The 10 year olds, on average, remained oriented while walking and were able to return to locations along the route when requested to do so.

The difference between these 6 year olds' performance and the performance of the 3- and 4 year olds in Darvizeh and Spencer's (1984) study may have been familiarity with the route and destination. In this study, the tester never explicitly taught the route to the subjects. Furthermore, the nature of this experiment was more difficult than Darvizeh and Spencer's test. The children in this study not only had to keep track of different locations along the route, but were asked to stop during the walk and answer questions about a wide variety of environmental concepts.

Signs. Two questions proved difficult for both age groups: "What does this part of the sign mean?" (all ways on a stop sign) and "Do you know where we might find the name of this street?" The 6 year olds also had difficulty answering the question, "Which street is Webster Avenue?" Each subject was asked to stand facing the street sign at an intersection. The tester pointed to the street sign for the street perpendicular to

the subject, read the street name, and traced her finger along the avenue. She then read the street name parallel to the subject and asked, "Which street is Webster Avenue?" All the 10 year olds answered this item correctly.

Traffic. Both the 6- and the 10 year olds responded correctly to three items: "Walk to a traffic light," "Point to the traffic," and "Who has the green light?" Most of the 6 year olds had difficulty responding correctly to the final three questions: "Point to the parallel traffic," "How many lanes of traffic are on this road?" and "Point to the intersection." On average, the 10 year olds completed all six items in this scale.

Landmarks. The 6- and 10 year olds listed similar landmarks, both primary and secondary, at each reporting station. However, the variety of landmarks listed by the subjects at each reporting station also seemed to fall into one of four descriptive categories based on their characteristics: primary, private, picture, and story. The term *primary landmarks* (Long & Hill, 1997) describes unique objects that are always present, for example, an address or a school building. The secondary landmark category was further divided into three categories: private, picture, and story. The term *private landmarks* refers to objects (like a small, yellow security sign) that are not usually helpful when giving others directions to a specific location but may be useful to the individual for wayfinding.

The subjects whose landmarks contained multiple descriptors of the area, rather than of a specific object, were placed in the picture category, since they presented a picture of what a place looked like. Rather than name an object, such as a building, they described the scene, for example, "tall trees

with no branches, small trees with a lot of branches" and "big, red, black, brown, lots of windows." Another type of response seems to be related to Darvizeh and Spencer's (1984) private category. In this case, the subjects related additional information about an area—in essence, told a story. Two examples are "Kids that had surgery can stay there with their parents" and "we went in a circle." In much the same way that a secondary landmark is seen as not always being present, these children used actions and memories for the same purpose as objects. Actions and memories may be equivalent to landmarks when linked to a unique location.

Siegel and White (1975) theorized that successful wayfinding requires at least some knowledge of the route, and Blades and Spencer (1988) theorized that children require sufficient experience in an area to develop knowledge of landmarks before they can find their way through an environment. Both groups in the current study listed similar landmarks, but differed in their ability to return to them. The findings suggest that the experience of walking an unfamiliar route once may be sufficient to allow 10 year olds to learn a route through an unfamiliar residential environment. However, even though the 6 year olds named landmarks along the route, they did not have enough experience in this area to enable them to return to these destinations.

LINKS TO THE FIELD OF O&M

The results indicate that 6 year olds' concepts related to O&M include cursory knowledge of addresses, traffic, signs, and landmarks. They suggest that 6 year olds with low vision who are unable to identify landmarks and lack basic concepts of resi-

dential neighborhoods should be considered at risk for developmental delays in O&M. However, 6-year-old children should not be expected to keep track of their location independently in unfamiliar areas.

Ambrose and Corn (1997) found that in familiar, indoor areas, children with low vision were independent travelers. However, the initial assessment of these children in an unfamiliar residential area determined that they were unable to remain oriented and lacked knowledge of environmental concepts that are necessary for residential travel. Ambrose and Corn also reported that although the O&M development of five 10- and 11 year olds with low vision may have been delayed, none of the children with low vision was receiving O&M instruction.

That the 10 year olds in this study demonstrated overall knowledge of the concepts that were tested and remained oriented in an unfamiliar residential setting suggests that by age 10, children are comfortable keeping track of their position when walking. Ten year olds are well aware of signage, are comfortable using street signs for orientation, and understand basic concepts associated with addresses and traffic. A typically developing 10 year old with low vision who is unable to remain oriented in an unfamiliar residential neighborhood may be considered delayed in O&M. Thus, an age-appropriate goal for children with low vision may be to travel independently in unfamiliar residential areas by age 10.

The performance of the sighted children in this study and in the studies found in the literature review suggests the need to assess the conceptual knowledge of children with low vision in both familiar and unfamiliar

environments indoors and outdoors. Children with low vision should have every opportunity to learn the patterns in their environments and need to receive daily reinforcement that predictable patterns in the environment exist and should be used to maintain or regain orientation. They should also be consistently given the responsibility of keeping track of their orientation while moving through the environment.

LANDMARKS

This study found that the use of primary landmarks is just one feature of the wayfinding of 6- and 10 year olds. Both age groups used at least three types of secondary landmarks when they described locations to the tester. Future studies should determine the importance of secondary landmarks for establishing locations in an environment. The study also indicated that the ability to identify landmarks at a specific location does not mean that 6 year olds will be able to return to that location once it is out of sight.

The findings have practical applications for instructing children in landmarks. All types of reference information should be reinforced in children; thus, instruction in landmarks should emphasize secondary, as well as primary, landmarks. Children should be reinforced in the knowledge that any and all information that enables them to know their location in the environment is valuable.

LIMITATIONS

The ACW holds promise as an instrument for measuring children's conceptual knowledge of the environment. At present, no other measure with which one can compare children's performance in wayfinding has been studied scientifically. Thus, more

studies of this kind are needed. However, the study had several limitations. One limitation is the ACW itself. Only three of the subscales were shown to be internally consistent. Furthermore, because the wording of the Likert-type responses may be skewed toward knowledge questions, rather than performance items, the wording of the scale may have to be changed or a separate scale for the performance items may need to be developed.

The small sample size and the population on which the study was conducted (the subjects' ethnicity was not recorded) are two other limitations. Therefore, the findings should be generalized only to children who are willing volunteers of research studies, who reside in or near a major metropolitan area, and have reading grades of B or higher in school. In addition, the results are not generalizable to children with cognitive, communicative, or motoric disabilities.

IMPLICATIONS FOR FUTURE RESEARCH

The study generated insights into factors that may be related to wayfinding and added to the empirical database on the assessment of O&M in children. However, more research is needed to develop protocols that assess children's age-appropriate O&M skills and to identify age-appropriate concepts for children aged 6 and younger. Future studies should concentrate on finding ways to describe more fully the conceptual knowledge of children and to develop formal assessment instruments that indicate O&M ability.

References

- Acredolo, L. P., Pick, H. L., & Olsen, M. G. (1975). Environmental differentiation and familiarity as determinants of children's memory for spatial location. *Developmental Psychology, 11*, 495-501.
- Ambrose, G. V., & Corn, A. L. (1997). Impact of low vision on orientation: An exploratory study. *RE:view, 29*(2), 80-96.
- Blades, M., & Spencer, C. (1988). How do children find their way through familiar and unfamiliar environments? *Environmental Education and Information, 7*, 1-14.
- Cornell, E. H., & Hay, D. H. (1984). Children's acquisition of a route via different media. *Environment and Behavior, 16*, 627-641.
- Cornell, E. H., Heth, C. D., & Broda, L. S. (1989). Children's wayfinding: Response to instructions to use environmental landmarks. *Developmental Psychology, 25*, 755-764.
- Cornell, E. H., Heth, C. D., & Rowat, W. L. (1992). Wayfinding by children and adults: Response to instructions to use look-back and retrace strategies. *Developmental Psychology, 28*, 328-336.
- Cousins, J. H., Siegel, A. W., & Maxwell, S. E. (1983). Way finding and cognitive mapping in large-scale environments: A test of a developmental model. *Journal of Experimental Child Psychology, 35*, 1-20.
- Darvizeh, Z., & Spencer, C. (1984). How do young children learn novel routes? The importance of landmarks in the child's retracing of routes through the large-scale environment. *Environmental Education and Information, 3*, 97-105.
- Guth, D. A., & Rieser, J. J. (1997). Perception and the control of locomotion by blind and visually impaired pedestrians. In B. B. Blasch, W. R. Wiener, & R. L. Welsh (Eds.), *Foundations of orientation and mobility* (2nd ed., pp. 9-38). New York: AFB Press.
- Herman, J. F., Kolker, R. G., & Shaw, M. L. (1982). Effects of motor activity on children's intentional and incidental memory for spatial locations. *Child Development, 53*, 239-244.
- Hill, E. W., & Ponder, P. (1976). *Orientation and mobility techniques: A guide for the practitioner*. New York: American Foundation for the Blind.
- Jacobson, W. H. (1993). *The art and science of teaching orientation and mobility to persons with visual impairments*. New York: AFB Press.
- Long, R. G., & Hill, E. W. (1997). Establishing and maintaining orientation for mobility. In B. B. Blasch, W. R. Wiener, & R. L. Welsh

- (Eds.), *Foundations of orientation and mobility* (2nd ed., pp. 39–59). New York: AFB Press.
- Lowenfeld, B. (1976) Introduction. In E. W. Hill & P. Ponder, *Orientation and mobility techniques: A guide for the practitioner*. New York: American Foundation for the Blind.
- Piaget, J. J., Inhelder, B., & Szeminska, A. (1960). *The child's conception of geometry*. London: Routledge & Kegan Paul.
- Poggrund, R., Healy, G., Jones, K., Levack, N., Martin-Curry, S., Martinez, C., Marz, J., Roberson-Smith, B., & Vrba, A. (1993). *Teaching age-appropriate purposeful skills: An orientation and mobility curriculum for students with visual impairments* (2nd ed.). Austin: Texas School for the Blind and Visually Impaired.
- Potter, L. E. (1995). Small-scale versus large-scale spatial reasoning: Educational implications for children who are visually impaired. *Journal of Visual Impairment & Blindness*, 89, 142–152.
- Rieser, J. J. (1979). Spatial orientation of six-month-old infants. *Child Development*, 50, 1078–1087.
- Siegel, A. W., & White, S. H. (1975). Development of spatial representations of large-scale environments. In H. W. Reese, (Ed.), *Advances in child development and behavior*, Vol. 10 (pp. 2–24). New York: Academic Press.
- Smith, A. J., & O'Donnell, L. M. (1991). *Beyond arm's reach: Enhancing distance vision*. Philadelphia: Pennsylvania College of Optometry Press.
- Spencer, C., Darvizeh, Z. (1981). Young children's descriptions of their local environment: A comparison of information elicited by recall, recognition and performance techniques of investigation. *Environmental education and information*, 1, 275–284.
- Tabachnick, B. G., & Fidell, L. S. (1989). *Using multivariate statistics* (2nd ed.). New York: HarperCollins.
- Welsh, R. L., & Blasch, B. B. (1987). *Foundations of orientation and mobility*. New York: American Foundation for the Blind.
- Williams, B. H., Hoff, H. E., Jr., Millaway, S. M., & Cassidy, M. M. (1982). *Project OMNI, orientation and mobility for needed independence: A prerequisite orientation and mobility skills development curriculum*. Norristown, PA: Montgomery County Intermediate Unit No. 23.

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